MULTIMEDIA UNIVERSITY

STUDENT ID NO

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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2019/2020

ECE 3086 – MULTIMEDIA TECHNOLOGIES AND APPLICATIONS

(All sections / Groups)

19 OCTOBER 2019
2:30 PM – 4:30 PM
(2 Hours)

INSTRUCTION TO STUDENTS

1. This question paper consists of 7 pages (including cover page) with 5 questions.
2. Attempt all **FIVE** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the answer Booklet provided.

QUESTION 1

(a) With the use of examples, compare the properties of static media and continuous media. Explain the **three** major difficulties when designing a multimedia system that requires the processing of continuous media. Suggest three solutions to overcome the three problems that you have identified.

[8 Marks]

(b) Pulse Code Modulation (PCM) is used to encode speech in digital format.

i) Explain the PCM encoding stages with the help of a block diagram. Describe the operation performed by each individual stage.

[8 Marks]

ii) It is known that maximum speech signal frequency is 10 kHz. Assuming 12 bits is used per sample, compute the minimum sampling rate that can be used. Calculate the bit rate for this mono audio stream with the use of minimum sampling rate.

[2 Marks]

iii) Propose two methods to increase audio signal quality by changing the encoding parameters.

[2 Marks]

Continued ...

QUESTION 2

(a) Colour (chroma) sub-sampling is a method to reduce video bit-rate when video is represented in YUV format. Explain the justification for this method by referring to the human visual system.

[4 Marks]

(b) With the use of a diagram, describe the 4:2:2 colour subsampling method on the YUV colour space.

[3 Marks]

(c) A full colour YUV video with 24 bits per pixel, spatial resolution of 620x480 and 60 frames/sec frame rate is generated by a video source. The video is to be transmitted over a network with bandwidth of 1.5 Mbps. **Compute the required compression rate**. The video use 8 bits for each YUV component value and adopt the 4:2:2 colour subsampling method.

[4 Marks]

(d) With the use of Huffman coding method, design the optimal **variable length code** for the symbols listed in Table 1. You will need to show the codeword for all the symbols. Compute average bits per symbol for the code that you have implemented.

[9 Marks]

Table 1

Symbols	Probability of Occurrence
S	0.375
L	0.25
E	0.25
O	0.125

Continued ...

QUESTION 3

(a) Explain the three major findings about the property of a typical image content and the imperfections in human vision that have been exploited by the JPEG (Joint Photographic Experts Group) technique to achieve high image compression capability.

[6 Marks]

(b) Describe the complete JPEG compression processes with the help of a suitable block diagram illustration. State whether a process or component has contributed toward either a lossless or lossy compression.

[7 Marks]

(c) Figure 3(a) shows the DCT coefficients matrix for an 8 x 8 image block and Figure 3(b) shows the corresponding 8 x 8 quantization matrix.

680	**74**	**-18**	20	-10	-1	1	-6
-44	**-25**	**11**	13	5	-3	15	-6
-12	**-4**	**5**	-9	3	-3	5	10
8	-10	4	4	-10	10	6	6
12	5	-1	-2	-10	9	-5	-1
5	9	-8	3	4	**-4**	**-12**	**2**
2	-2	3	-1	1	**3**	**-3**	**-2**
-1	1	0	2	3	**-2**	**-4**	**-2**

Figure 3(a): 8x8 DCT Coefficients Matrix

16	11	10	16	24	40	51	61
12	12	14	19	26	58	60	55
14	13	16	24	40	57	69	56
14	17	22	29	51	87	80	62
18	22	37	56	68	109	103	77
24	35	55	64	81	104	113	92
49	64	78	87	103	121	120	101
72	92	95	98	112	100	103	99

Figure 3(b): 8 x 8 Quantization Matrix

Continued ...

(c)

(i) Compute the quantized DCT coefficients in the top left 3x3 coefficients matrix and bottom right 3x3 as highlighted in Figure 3(a). Use the function $f(x)$ = round(x) for quantization. The function round(x) rounds each element of x to the nearest integer. In the case of a tie, where an element has a fractional part of exactly 0.5, the round function rounds away from zero to the integer with larger magnitude. For example, round(1.5) = 2 and round(-1.5) = -2 .

[4 Marks]

(ii) Provide an explanation for the observation found in (c) (i). Thus, propose a simple strategy to improve the compression ratio.

[3 Marks]

QUESTION 4

(a) Explain the concept of "Temporal Redundancy" and how it is being used as the underlying idea of video compression.

[4 Marks]

(b) MPEG video compression results in I-frame, P-frame and B-frame being generated from the raw video frames.

i) Identify and explain which frame among the I-frame, P-frame and B-frame is the most similar to JPEG compressed image.

[2 Marks]

ii) Identify and explain which frame among the I-frame, P-frame and B-frame takes the longest time to encode in order to achieve the highest compression ratio.

[2 Marks]

iii) Compare the complexity of the video encoder and decoder by providing proper justifications.

[2 Marks]

Continued ...

(c) By examining the Differential Pulse Code Modulation (DPCM) encoder and decoder depicted in Figure 4(a) and Figure 4(b) respectively, explain why prediction in the encoder is based on the reconstructed signal $\tilde{f}_n$ instead of the actual signal f_n. Why is the predictor important in DPCM encoder?

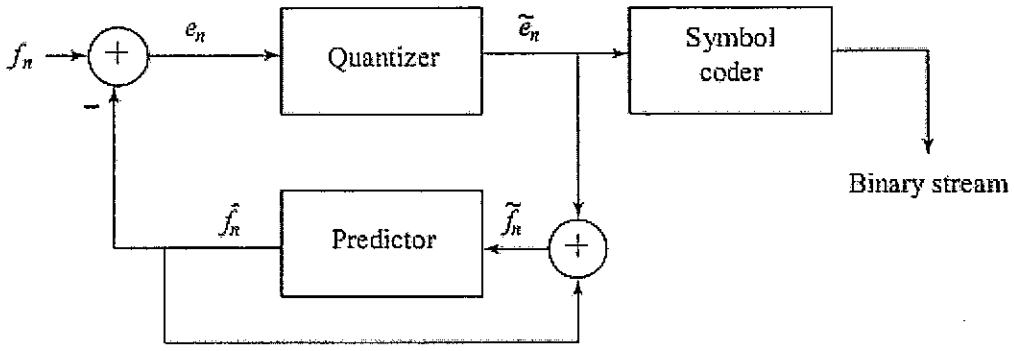

Figure 4(a): DPCM Encoder

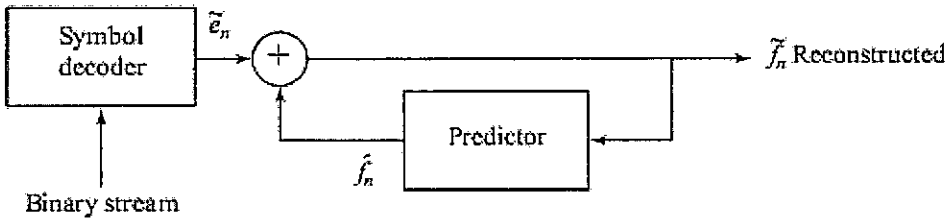

Figure Q4(b): DPCM Decoder

[4 Marks]

(d) Propose and describe three possible methods to increase the compression rate of the DPCM encoder.

[6 Marks]

Continued ...

QUESTION 5

(a) The following three questions are related.

i) Propose and implement an indexed image scheme that is able to display 256 selected colours.

[6 Marks]

ii) Compute the optimal bits per pixel for your proposed method.

[2 Marks]

iii) What is the advantage and disadvantage of such scheme when compared to true color image?

[2 Marks]

(b)

A content based image retrieval system enable a user to easily find similar images in a database by using an example image as query. Propose and design a simple content based image retrieval system using query by example approach. The system uses colour histogram in YUV colour space as image descriptor. Describe the processing steps and show the block diagram for the database preparation process and the image searching process.

[10 Marks]

End of Paper